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REPORT NO. 797

A COMPARISON OF TWO METHODS OF SCALING PAIN

(Progress Report)

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Lee S. Caldwell, Ph. D.
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ABSTRACT

A COMPARISON OF TWO METHODS OF SCALING PAIN

OBJECTIVE

To compare two methods of scaling pain: one in which the subject reports the time of appearance of the various pain intensities, and the other in which the subject reports pain intensity at irregular times indicated by the experimenter.

METHOD

Sixteen male students were required to maintain grip strengths equal to 25% and 40% of their maximum as long as possible and report their pain sensations using both the self-paced and irregular methods of reporting. In addition, performance was measured using both five and ten point scales.

SUMMARY

A small, but statistically significant, difference in results was obtained with the two scaling methods, principally at the maximum intensity. Also, the size of the scale unit influenced the ratings, as previously reported, but the reason remains obscure.

CONCLUSIONS

The high degree of comparability of the results with the two methods of scaling indirectly suggests that the linearity of the pain and effort functions previously obtained was not due to the subject's fractionating his contraction time, but rather that the sensations increased linearly with time.

A COMPARISON OF TWO METHODS OF SCALING PAIN

INTRODUCTION

Caldwell (2) and Caldwell and Smith (3) have shown that a simple technique may be used to assess the subjective components of performance decrement (fatigue) produced by isometric muscle contractions. They obtained essentially linear functions relating the intensity of noxious sensations to contraction time. This may reflect a linear growth of the sensations, as concluded by the authors and by Hosman (4), but it is also possible that the linearity may be due either to a tendency of S to estimate his endurance at the beginning of the performance and divide the estimated total time into the appropriate number of parts, or simply to repeat the first temporal interval. These latter interpretations are somewhat weakened by observations that linear functions are obtained even with loads novel to the subjects or with novel conditions such as circulatory occlusion (2) or curarization (8), which would preclude accurate estimation of endurance time.

A method devised by G. M. Smith, et. al. (7), and first reported by Beecher (1), offers an opportunity for a further test of Caldwell and Smith's conclusion, as this technique requires the subject to report his sensations of pain at irregular, unpredictable intervals so there should be no tendency to concentrate on time rather than on the sensations. The primary purpose of the present report is to compare the self-paced method of Caldwell and Smith with the irregularly-paced method of G. M. Smith, et. al.

METHOD

Subjects. Sixteen male college students served as subjects. Their ages ranged from 18 to 24 years with a mean of 19.8 years. The men were unselected with respect to size or strength, and none had served in similar studies previously. Participation in the study satisfied a requirement for a psychology course in which the men were enrolled.

Apparatus. The apparatus was an adjustable isometric hand dynamometer with strain gauges, a strain amplifier, an ink-writing recorder, and a voltmeter with a scale marked in pounds which served as a subject display. The apparatus has been described in greater detail elsewhere (2).

Procedure. Prior to the experimental sessions, the subjects were given practice in the scaling procedures to be used in the study. In this practice session, the handle was carefully adjusted for subject differences in hand size, and grip strength was determined for both hands. The subject was then told to take the dynamometer in his left hand and to squeeze just hard enough to turn on the indicator lamp and to keep it on as long as possible. This lamp, which was mounted on the display meter and controlled by an adjustable relay, was set to light up when the applied force equalled half the subject's grip strength. The subjects received practice with four procedures—reporting the time of appearance of the various pain intensities, using both five and ten point scales, and estimating the intensity of the sensation on both scales when interrupted on a random schedule. All practice was at a 50% load, not at the loads used in the experiment. Interruption times of 9, 16, 26, 32, 40, 48, 53, 59, 66, 75, 85, 93, 100, 105, 112, 120, 128, 134, 142, and 148 seconds were determined by drawing at random from the numbers five through ten and adding the result to the previous total. The subjects were told they could terminate performance if the pain became intolerable.

In the experiment proper there were eight conditions formed by the factorial combination of two loads (25% and 40% of maximum strength) with two scales (five and ten points) and two scaling methods (self-paced and irregular). The eight experimental combinations were presented in two sessions of four trials each. The four trials were presented in a counterbalanced order, and the use of both hands was alternated to reduce fatigue. Ten minute rests were given between trials.

RESULTS AND DISCUSSION

The data were treated by an analysis of variance for repeated measures. Because the analysis was quite complex, yielding many higher order interactions, only the more meaningful statistically significant sources of variance were considered. To compare the results for the two scales, only the scores for points 2, 4, 6, 8, and 10 of the ten point scale were used in the analysis. These points from the ten point scale represent the same sensation levels as do the points on the five point scale. The effect of loads was significant at the 1% level of confidence ($F_{1, 15} = 11.29$), indicating that with an increase in load from 25% to 40% of maximum strength, there was a general tendency to report the pain levels earlier in the performance. It may be seen in Table 1 (next page) and in Figures 1 and 2 (pages 4 and 5) that every

TABLE 1

Time in Seconds to Reach Various Pain Intensities for Five and Ten Point Scales for Two Scaling Methods

	25% Load						40% Load					
	Self-Paced			Irregular			Self-Paced			Irregular		
	(10)	(5)	M	(10)	(5)	M	(10)	(5)	M	(10)	(5)	M
1	(8.9)*			(6.9)			(6.0)			(6.5)		
2	16.0	9.8	12.9	15.0	8.3	11.6	12.0	5.9	9.0	12.0	7.9	10.0
3	(23.5)			(23.1)			(17.3)			(18.5)		
4	30.7	21.9	26.3	30.9	21.2	26.1	22.8	15.4	19.1	23.9	18.2	21.1
5	(37.3)			(38.8)			(28.7)			(30.2)		
6	44.7	35.6	40.2	45.2	34.9	40.1	35.1	26.6	30.8	36.2	31.6	33.9
7	(51.6)			(53.5)			(40.3)			(42.3)		
8	60.7	53.8	57.2	61.4	54.1	57.8	46.1	40.5	43.3	48.8	43.3	46.1
9	(68.9)			(70.4)			(51.3)			(54.6)		
10	80.4	72.6	76.5	95.6	88.8	92.2	61.8	62.3	62.1	63.5	65.5	64.5
M	46.5	38.7	42.6	49.6	41.5	45.6	35.6	30.1	32.9	36.9	33.3	35.1

*Figures in parentheses not included in data analysis, or in means.

intensity was reported sooner for the 40% than for the 25% load, demonstrating the sensitivity of the scaling to contraction strength. A significant interaction between loads and intensities ($F_{4, 60} = 14.11$; $p < .01$) indicated that increasing the load did not produce a uniform decrease in the contraction time required to induce the various pain levels. That is, the difference between the times of reporting the first level of pain (the second point on the ten point scale) for the two loads was 2.7 seconds, and for the terminal level it was 21.1 seconds. Increasing the load simply increased the slope of the pain function without altering the Y-intercept, thus producing the greatest change at the highest pain intensity. There was no indication from the statistical analysis that the magnitude of the load effect was influenced either by the size of the scale interval, or by the method of reporting.

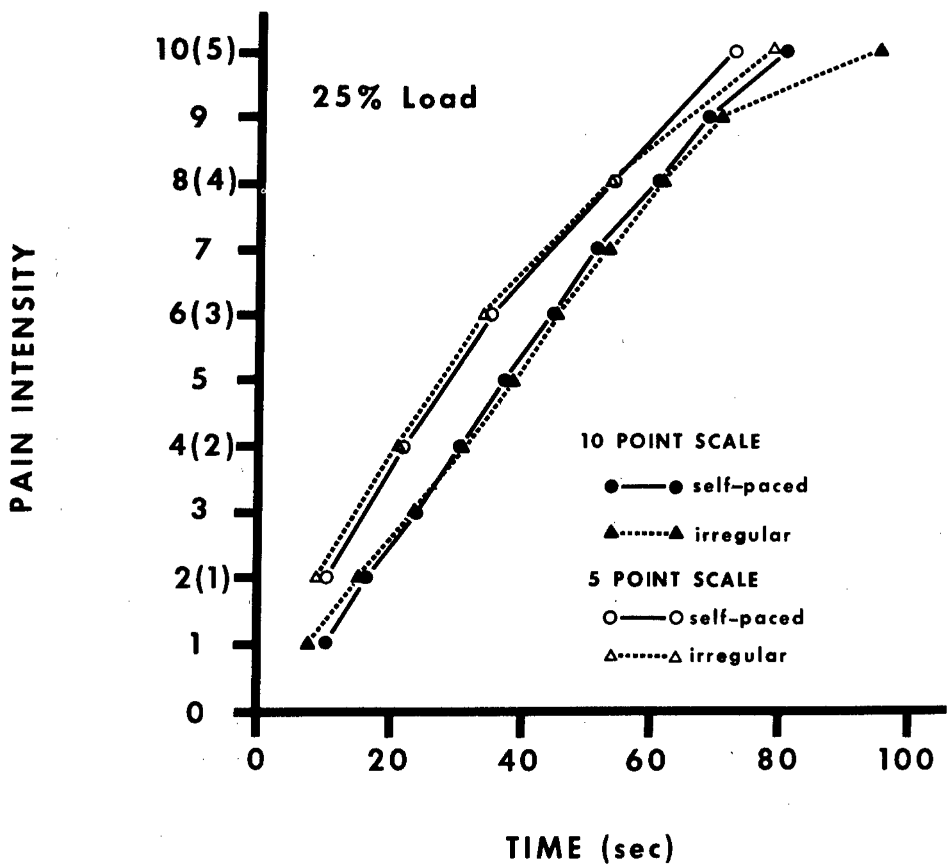

Fig. 1. Pain ratings for a 25% maximum load for both five point and ten point scales using self-paced and irregular (experimenter-paced) methods of reporting.

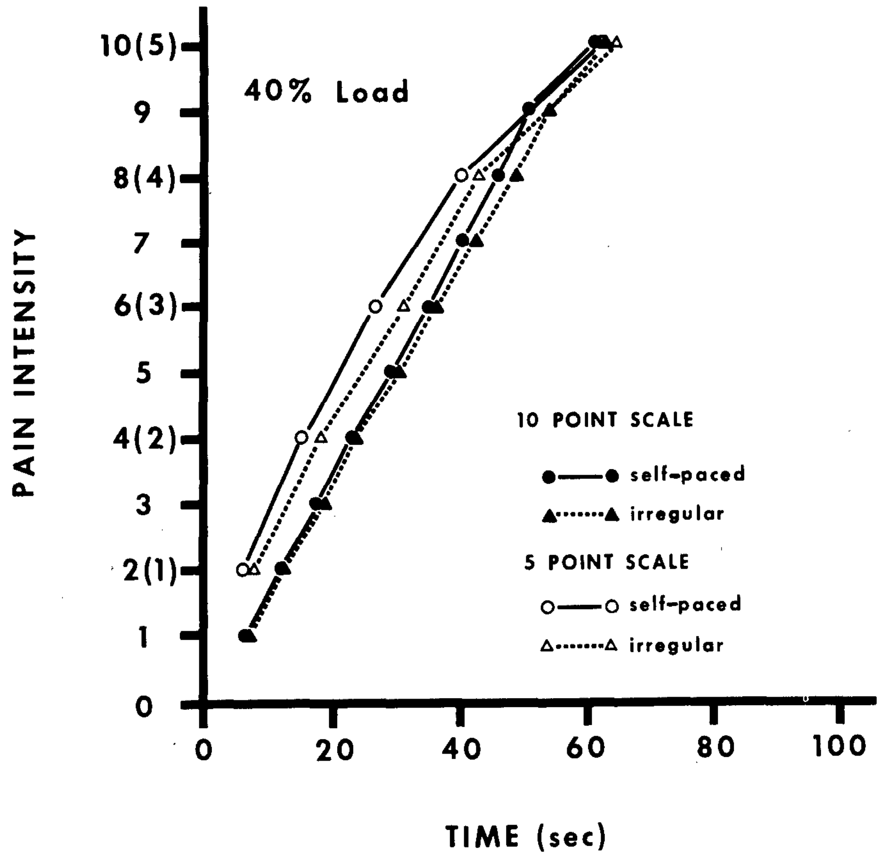

Fig. 2. Pain ratings for a 40% maximum load for both five point and ten point scales using self-paced and irregular (experimenter-paced) methods of reporting.

The scaling method had a significant effect ($F_{1, 15} = 12.89$; $p < .01$) on the times at which the pain levels were reported. The various levels of sensation were reported earlier when the subject was free to announce their times of appearance than when he was required to estimate the intensity of the sensation at the request of the experimenter. The mean difference between the two methods was 2.6 seconds, but it varied from 0.1 second at the first level to 9.1 seconds at the final level. This interaction between the methods and intensities was significant at the 1% level of confidence ($F_{4, 60} = 15.50$). Figures 1 and 2 show that the reporting method had its greatest effect at the terminal intensity for the 25% load. This terminal effect may have been due to a reluctance of the subjects to terminate performance until the experimenter called for a report, though they were told they could call out the number corresponding to the final level and stop when the pain

became too intense. The difference between the methods may also reflect the influence of the experimenter on the subject's performance. That is, the personal interaction between the experimenter and the subject in the one procedure may have increased the motivation of the subject and thus increased his pain tolerance, especially at the lighter load with its relatively slow rate of increment of pain.

The data obtained with the five and ten point scales were compared and it was found that all pain intensities were reported sooner on the coarse scale. The mean difference of 6.3 seconds between the two scales was significant at the 1% level of confidence ($F_{1, 15} = 13.07$). This difference in rating as a function of scale interval size was reported in a previous study (3), but the cause still remains obscure. This may reflect a tendency to set the first point of the scale at the pain threshold, and the other reports being made relative to that value. At the present time, there is insufficient data to determine precisely what influence the coarseness of a scale has on the ratings of a sensation, but these results indicate the presence of a substantial effect attributable to the scale unit size independent of the range of sensations judged.

The primary concern in this study was the comparison of two rating methods. The comparability of the pain functions yielded by the two methods suggests that the linearity of the curves previously obtained with the self-report procedure was not due to the subjects fractionating time, because essentially linear functions were obtained even with irregular reporting times selected by the experimenter. A quadratic component is evident in the pain functions, but it is small relative to the linear component. Most of the curvilinearity can be accounted for by the comparatively long interval between the last two scale points. This may represent an end spurt, or a tendency to maintain a reserve to the last and then to go all out. It may be, too, that for these comparatively light loads and the longer contraction times that fatigue was attenuated by recovery phenomena. Both of these loads were well below the value at which internal pressure in the muscle occludes the blood supply (2, 5) so that some recovery was possible during the performance. The differences attributable to the main effects of methods, though statistically significant, were small. Thus, there is no basis at the present time for saying that one method is better or more orderly than the other for scaling pain. There is one consideration, however, which would seem to mitigate against the use of the method which requires active participation of the experimenter in the ratings: the personality of the experimenter—or the relationship between the experimenter and the subject—may influence the results,

as indicated by Kohfeld and Weitzel (6). This difficulty might be overcome by replacing the experimenter with a signal or by using a recorded voice to indicate the reporting times, but the division of attention between the sensation and the signal may prove distracting.

SUMMARY AND CONCLUSIONS

Sixteen subjects were required to estimate the pain or discomfort produced by isometric muscle contractions maintained to exhaustion. Eight experimental conditions were produced by factorially combining two loads (25% and 40% of maximum strength) with two scales (five and ten points) and two scaling methods (self-paced and irregular). It was found that an increase in load simply increased the slope of the pain function with the Y-intercept remaining at or near zero, thus producing the greatest effect at the higher pain intensities. The magnitude of the load effect was independent of the scaling method and the size of the scale interval. A small, but statistically significant, difference in results was obtained with the two scaling methods, principally at the maximum intensity. This result may be due to the subject's reluctance to terminate performance before the experiments called for a report, or it might simply have reflected a difference in the motivation of the subject produced by the active participation of the experimenter in the scaling procedure. Also, it was found that the size of the scale unit influenced the ratings, as previously reported, but the reason remains obscure.

In general, the pain ratings were similar whether the subject reported the time of appearance of the various pain levels, or whether he reported the intensity of pain experienced at times designated by the experimenter. There is little reason at present to prefer one method to the other, except that other research has demonstrated the possibility of a strong biasing of results produced by the presence of other persons in the testing situations. The comparability of the results yielded by the two methods indirectly suggests that the linearity of the pain and effort functions previously obtained was not due to the subject's fractionating his contraction time, but rather that the sensations increased linearly with time.

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13. ABSTRACT

Sixteen subjects were required to maintain grip strengths equal to 25% and 40% of their maximum as long as possible and to report their pain sensations using both self-paced and irregular, experimenter-paced methods of reporting. In addition, results were compared using five and ten point scales. A small, but statistically significant, difference in results was obtained with the two scaling methods, principally at the maximum intensity. Also, the size of the scale unit influenced the ratings, but the reason remains obscure. The comparability of the results with the two methods of scaling indirectly suggests that the linearity of the pain and effort functions previously obtained was not due to the subject's fractionating his contraction time, but rather that the sensations increased linearly with time. (U)

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